Art of Signaling.

Finley's Heliotrope

AN IMPROVED METHOD

IN THE

ART OF SIGNALLING

FOR

MILITARY AND SCIENTIFIC PURPOSES.

One Instrument for both Day and Night Work.

FINLEY'S HELIOTROPE

OR

NEW HELIO-TELEGRAPH

MANUFACTURED BY THE

AMERICAN HELIO-TELEGRAPH AND SIGNAL LIGHT COMPANY.

WASHINGTON, D. C.

1887.

AMERICAN

Helio-Telegraph & Signal Light Compa

WASHINGTON, D. C.

Company's Office, 317 Sixth Street N.W.
Company's Shops, 316–322 Thirteenth Street N.W.

THOMAS SOMERVILLE, *President.*
ROBERT T. HIESTON, *Secretary.*

FINLEY'S HELIOTROPE OR NEW HELIO-TELEGRAPH.

This cut represents the complete instrument with attachments for lanterns and mirrors, using but one of each with the accompanying screens.

An army can have no better outpost, from which to watch the movements of an enemy, than a signal station, and, with a practised signal officer at such a position, no force can move without being detected.

—Brigadier General GEO. A. CUSTER, U. S. Army.

The Signal Corps has been of great use to the army, and I look upon it as a necessary part of our military establishment.

—Major General GEORGE SYKES, U. S. Army.

A Signal Corps is one of the essential organizations of a well-appointed army.

—Major General GEORGE H. THOMAS, U. S. Army.

Military signalling must always be of value in hilly or mountainous regions and in the open country.

—Major General ALFRED H. TERRY, U. S. Army.

The Signal Corps has transmitted orders and brought me information of the greatest inportance that could not have reached me in any other way.

—General W. T. SHERMAN, U. S. Army.

AN IMPROVED METHOD IN THE ART OF SIGNALLING.

SIGNALS.

A signal is any means employed to excite attention and convey intelligence.

Primarily, signals are of two kinds—transient and permanent.

Transient: those in which each symbol disappears after completion.

Example: signals by motions, sounds, &c.

Permanent: those in which each symbol remains in position after completion.

Example: a hoist of flags, &c.

Signals are generally employed for military purposes; yet in certain scientific and commercial pursuits they have become extremely useful.

Signals may be made in a great variety of ways, and with almost every conceivable form or kind of material.

The underlying principle of all systems of signals is the joining together, in any arrangements or combinations which are possible and expedient, a certain number of arbitrary simple signs, sounds, things, colors, or indications, in order to form other or different signals to any extent required.

A code of signals is a collection of symbols arranged and

agreed upon, each symbol having a certain meaning assigned to it.

Codes are designated by the number of elements employed in making the signals, or with reference to the different kinds of symbols which appear in the record.

The formation of codes of signals depends upon the application of certain mathematical rules for permutations, combinations, and arrangements, by means of which any number of signs or symbols being given there can be determined the number and qualities of all the changes, combinations, and arrangements in which it is possible to place the given elements together.

While there is a great variety in the method and appliances for the formation of signals, the majority are restricted to short range work.

For military purposes and for scientific work in geodetical measurements, long range signalling is imperative.

The requirements of an apparatus for the work here indicated demand that it shall be effective at distances ranging from 25 to 200 miles.

The ordinary means of signalling, viz., by flags, torches, rockets, semaphores, homographic symbols, and the like, are only serviceable for distances ranging from 1 to 20 miles, even with the aid of powerful glasses.

THE HELIOGRAPH.

This instrument outranks all other appliances for long range work, and has proved effective at distances of 190 miles.

By the term heliograph we mean an instrument employed

for transmitting signals by sun reflections from a plane mirror.

The principles involved in the construction and operation of the heliograph are simple and easily acquired.

Symbols by the heliograph are transient signals.

The signals are made by so exposing the mirror as to direct the reflections upon some point of observation.

Heliograph signals are of two kinds:

FLASH SIGNALS.

LIGHT HIDDEN WHEN NOT OPERATED.

1st. By a movable screen revealing and obscuring at will reflections from the mirror.

2d. By a movable mirror adjusted to be thrown in and out of focus at will.

OBSCURATION SIGNALS.

LIGHT EXPOSED WHEN NOT OPERATED.

1st. By a movable screen obscuring and revealing at will reflections from the mirror.

2d. By a movable mirror adjusted to be thrown out and in of focus at will.

To many operators the method of dark signals offers advantages in the readiness with which they can be distinguished, and the fact that to observe them is less tiresome to the eye.

The constituent parts of a heliograph are (without enumerating every detail) as follows:

Tripods, plane mirrors from 3 to 12 inches in diameter, square or round. Carrier bar for attachment and support of mirrors.

Sighting rod of various designs. Screen for obscuring and revealing the mirror. Key attachment for operating screen.

Leather or canvas cáses for packing up the parts of the instrument.

The present forms of heliograph are known by the name of the persons designing the same, as—

The Mance Heliograph (English).
The Begbie " "
The Grugan " (American).
The Garner " "
The Purssell " "

All of the above instruments are operated to produce the Flash Signals.

When used to transmit signals by the Morse (Army and Navy) code the dash elements are determined by the length of the flash; that is, the time during which the mirror is exposed is longer for the dash than for the dot, the difference being dependent upon the judgment of the operator in manipulating the screen.

All of the above instruments use a single mirror with sighting rod, when the sun is in front of the operator, and two mirrors when the sun is in rear of the operator.

The Grugan and Purssell instruments both use two tripods, one to support the mirrors, forming what is called the heliograph, and the other, to support the screen, forming what is called the heliostat.

The remaining instruments (except the Mance, two tripods) employ one tripod and no screens, the flash signals being made by the operation of a movable mirror, the re-

flection from which can be thrown on or off any given spot by the manipulation of a finger key at the back of the mirror.

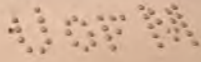
In all of the above instruments there are no means provided for distinguishing between symbols of greater or less magnitude, except by the longer or shorter exposition of the same visible signal.

The duration of exposition depends upon the judgment of each operator, and necessarily leads to many errors in both sending and receiving. Even if the time or interval was definitely determined, it would require a great amount of practice to become proficient; but no amount of practice would prevent frequent liability to error.

In the transmission of speech or messages through the medium of visible signals by the Morse (Army and Navy) alphabet or code, or any other similar code in which the letters, numbers, or signs are formed by symbols of greater or less magnitude reproduced by the longer or shorter exposition of the visible signal or by a greater or shorter range of movement of such signal, one serious difficulty has heretofore been encountered.

This difficulty consists in the inability of the receiver to properly distinguish the letters, numbers, or signs formed by the longer or shorter exposition or range of motion of the signal.

For example, in the Morse (Army and Navy) code, which is the standard used in field signalling for military purposes, it has been found very difficult to properly distinguish the longer period of exposition of the signal in forming the "T" dash from the shorter periods of exposition of the signal in forming the dot, or the "M" dashes from the "N" *dash and dot.*



In other words, to make the dash element the operator must expose the visible signal, whatever it may be, for a longer period than when making the dot element. This will always be the case where the symbols of any code differ in magnitude, and practically, all codes for visual signalling are constructed with such means for distinguishing the elements.

The question of magnitude in symbols introduces a very troublesome element in the operations of visual signalling where the making of them depends upon the exposition of a single visible signal.

No matter if instructions clearly define that one symbol is exactly two or three times greater than another the difficulties of the operator are not in the least diminished.

It will require long practice and the most expert manipulation to become proficient in the making of signals consisting of symbols of different magnitudes by the exposition of a single visible signal.

For example, the letter "B," in Army and Navy code, is symbolized by a dash and three dots (— · · ·). To make this signal by operating any of the present forms of heliograph requires one long exposition of the mirror followed by three short expositions of precisely the same signal.

Unless these long and short flashes are timed with the utmost precision by the sender the signal will either be unintelligible to the receiver or entirely represent some other signal than that for which it was intended.

Dash and three dots (— · · · = B) may appear to the receiver as (— — · = G), or as (· · · · = H), in fact, it is possible, by a mere slip in timing the exposition of the *signal in* making the letter "B," to produce any one of

twelve (12) different letters in the Army and Navy code with the present form of heliograph.

Similar difficulties will arise in transmitting the other letters of the alphabet.

It will not do to say that the receiver may decipher the signal from what has gone before in the message, or that he can blindly record what he chances to obtain, and then at the close of the message try to supply the defects from the context.

This is guess-work, and cannot be tolerated in either military or civil operations.

An operator may become expert in the manipulation of the present form of heliograph, but such proficiency is exceptional; requires constant and unremitting practice to maintain it, and, no matter how successful the operator, he is constantly subject to error, which the least inattention will cause him to make.

The heliograph must be so constructed and operated as to make it efficient in the hands of any man after preliminary instruction concerning the setting up of the instrument.

In the operation of the instrument, while in the act of transmitting signals, the chance of error must be reduced to the lowest possible minimum.

As symbols of different magnitudes will always occur in any code of signals, their production must not be made to depend absolutely upon the judgment and experience of the operator, but upon some mechanical contrivance in the simple operation of which clear distinction and separation is made absolutely certain.

The entire attention of the operator should be given to the necessary adjustments of the instrument, and the watching *of the opposite* station.

For example, in making the dash and dot of the Army and Navy code, the operation should not result from an effort of the mind to determine their relative magnitude, but should be purely mechanical.

In the practice of telegraphy the circumstances are somewhat analogous.

The sense of hearing is the agency which renders intelligible the varying lengths in the waves of sound, and it is a well-known fact with telegraph operators that it is much more difficult to *send* than to *receive* a message, because of the obstacles encountered in educating the mind to accurately and rapidly estimate the relative magnitude of different symbols.

In fact, the expert telegraph operators are such because long and incessant practice has made their manipulation of the finger key *mechanical*.

Now this result is precisely what we want to secure in the heliograph, but without the necessity of months and years of practice. The instrument itself must accomplish the desideratum that is sought for.

FINLEY'S HELIOTROPE OR IMPROVED HELIO-TELEGRAPH.

The object of this invention is to provide a novel mode of transmitting speech or messages through the medium of visible signals by any code in which the letters, numbers, and signs are produced or formed by the exposition of a visible signal for a longer or shorter period of time, corresponding to symbols of greater or less magnitude, as, for instance, the dash and dot of the Morse (Army and Navy) code, *enabling any* one familiar with that code to more or less

rapidly transmit the speech or message, or to receive the same with absolute correctness.

In this instrument the means provided for making symbols of greater or less magnitude without recourse to the exposition of a single visible signal for a longer or shorter period of time has been rendered purely *mechanical*.

One or more signals are exposed to view, according to the magnitude of the symbol or symbols corresponding to a given letter to be transmitted.

For example, in the Morse (Army and Navy) code the dash is formed by the simultaneous exposition of two signals, while for the dot but one signal is exposed to view.

From the principle involved in the Finley heliotrope, it is obvious that, by varying the number of signals according to the magnitude of the symbol or symbols that represent a given letter, all liability to error is avoided, and any one acquainted with the code will be able to transmit and receive speech or messages with absolute accuracy. We may suppose the conditions of the atmosphere to be such that the two lights or flashes, representing the dash, or element of greater magnitude, could not be distinctly separated by the eye or telescope, yet this signal would be quickly distinguished from the dot, or element of less magnitude, because of the greater size and peculiar form of the light exhibited by the double signal. There is no possibility of confusing the two signals if the instrument is kept in proper adjustment while operating it. This precaution is, of course, required of any instrument.

This novel mode of signalling will be readily comprehended from the following explanation:

The letter "M," which consists of two dashes, is formed by the simultaneous exposition to view of two signals, repeated at a short interval.

The letter "A," consisting of dot and dash, is formed by the exposition of one signal followed by two signals, exposed simultaneously.

The letter "C," consisting of one dash, dot, dash and dot, is produced by the simultaneous exposition of two signals, then one signal, then again two signals, and, finally, one signal.

It will be readily seen from what has now transpired that, whatever the nature of the signal, if a code of them be so arranged that they can be manipulated, as described, no difficulty will be encountered in transmitting speech or messages with absolute certainty.

The Finley heliotrope consists of the following parts, which are readily packed in suitable cases and carried by one man:

One tripod; one signal carrier bar; one compass; two mirror bars; four mirrors; one telescope, holder and quadrant; one register; two screens; two lanterns; one oil-can; one screw-driver; one plumb-line and bob; two rolls of message paper.

The entire instrument is distributed in three cases, as follows:

CASE No. 1.—DAY AND NIGHT WORK.

One tripod; one signal carrier bar; one telescope; two mirror bars; one plumb-line and bob.

CASE No. 2.—DAY WORK.

Four mirrors; one screw-driver; two extra rolls message

paper; one register; one telescope holder; one telescope quadrant; two screens; one compass.

CASE No. 3.—NIGHT WORK.

Two lanterns; one oil-can; two extra rolls message paper; two extra lamp-wicks; one box of matches.

When a signalling party goes out for night work, the following additional articles will be carried in this case, under which circumstances they will be taken from Case No. 2: One compass; one screw driver; one register; one telescope holder; two screens; one telescope quadrant.

If the signalling party goes to the field for both night and day work, all three cases will be carried, and the various parts mentioned in connection with Cases Nos. 2 and 3 can be evenly distributed between the two so as to equalize the weight for the man's shoulders while carrying them.

Cases Nos. 2 and 3 will be suspended from the right and left shoulders, respectively, passing diagonally across the body and resting near the hips.

Case No. 1 may be carried in either hand, swung diagonally across the back, or supported on the shoulder.

INSTRUCTIONS FOR SETTING UP.

DAY WORK.

INSTRUMENT FACING THE SUN.

1. Set the tripod firmly on the ground by pressing the feet well into the earth.

2. Screw the compass to the upper cap of the tripod, and adjust so that the E. and W. points shall be in line with the signal carrier bar (the long transverse bar supporting the mirror bars).

3. Place the signal carrier bar upon the upper cap of the tripod and over the compass, the long screws passing downward on either side, and held firmly in position by milled nuts. Clamp the upper cap to the head of the tripod by the long screw with milled head.

4. Screw the telescope holder to the centre of the flanged bar resting over the compass.

5. Place the telescope in the adjustable ring of the holder and clamp tightly, after which attach the quadrant so that the graduated end passes through the slot in the standard of the telescope holder. Clamp all parts until ready for operating.

6. Slide the mirror bars, one on each end of the signal carrier bar, and clamp them at any required distance from the centre of the instrument.

In placing the mirror bars on the signal carrier bar they should be so adjusted that the end of each, carrying the sighting rod, is on the rear side of the signal carrier bar.

7. Place one mirror on each bar so as to face the opposite station. Place the sighting rods into the slots (one on each bar) and connect them with the ratchet pinion, which provides for the vertical adjustment.

8. Attach the screens to the bar for revolving them, one in front of each mirror. Attach the jointed end of the finger keys to the small brass pieces, just above and on either side of the compass. The keys and screens are now in position to obscure or reveal the mirrors at the will of the operator.

9. Attach the register for recording the message to the *upper cap* of the tripod. The register may be used for re-

cording either the message sent or received, but more frequently it will be employed for the latter.

The register has three finger keys, the two outside ones being depressed simultaneously to record a dash or signal of greater magnitude, and the central key depressed to record the dot or that of less magnitude.

The message is recorded on a fillet or roll of paper, which moves forward as the keys are operated just rapidly enough to secure a proper and regular interval between the separate signals or letters.

To distinguish between successive letters in the same message the three keys are depressed at once as the symbol for end of letter; twice for end of word; three times for end of sentence, and four times for end of message.

As the message proceeds the paper is reeled out, moving one-eighth of an inch for every element recorded. At the end of the message the record is detached and the inscription read.

10. Adjust the instrument carefully, using for that purpose the three levelling screws attached to the upper plates of the tripod. In making this adjustment the instrument should be levelled over some fixed point on the ground (centre of small stake driven in the earth), using the plumb-line and bob.

11. Adjust the telescope upon the opposite station and, when the view is well defined, clamp all parts and take the readings in degrees and minutes from the compass and the graduated arm of the telescope; the former will give the departure and the latter the latitude of the opposite station. A record should be made of these readings so that the in-

strument can afterwards at any time be set at this point and bring the opposite station at once within the field of view of the telescope.

This arrangement and precaution is especially necessary when both day and night work is to be performed from the same station.

Having marked the place on the ground over which the instrument was operated during the day, the operator can return at night, plumb his instrument over the exact spot, adjust the compass and telescope quadrant until the readings for latitude and departure are obtained, when, upon looking through the telescope, the opposite station should be directly within the field of vision.

12. The instrument is now in position for the first adjustment of mirrors and sighting rods, preparatory to the transmission of signals.

13. Direct the mirrors roughly on the distant station.

14. Place yourself in front of the right mirror, with your back to the distant station.

15. Move the head and eye until the distant station is reflected in the exact centre of the mirror.

16. Then, without moving the head, adjust the sighting rod until the reflection of the sighting spot is brought accurately in line with the centre of the mirror and the reflection of the distant station. The accuracy of this alignment is easily tested by raising the eye a little above the line and then a little to the right or left; it can easily be seen if the reflections are in a true line vertically and horizontally.

17. The sighting spot is now in a direct line between the distant station and the centre of the mirror, no matter what

the direction or inclination of the latter, and *must not be disturbed* as long as communication is kept up with the same station.

18. Place yourself in rear of instrument and move the mirror to throw a full reflection on the sighting rod, adjusting the former until the shadow spot exactly covers the sighting spot.

19. The flash will now be thrown upon the distant station, and the right-hand mirror is ready for work.

20. The left-hand mirror should be operated with in precisely the same manner in order to make its adjustment complete.

21. While adjusting each mirror, the reflection from it should be hidden from the view of the opposite station by an adjustment of the screens to exactly cover the mirrors.

22. The shadow spot here referred to is defined as follows:

A small circle in the centre of each mirror is left unsilvered, and therefore cannot reflect the rays of the sun, and this unreflecting circle causes a small disc of shadow to be projected in the centre of the reflected cone of light.

23. The sun having continually an apparent motion in the heavens, the shadow-spot is constantly in motion, and can only be kept adjusted by altering the direction of the mirrors so that it shall be maintained continually upon the sighting spot, which is the enlarged upper portion of the sighting rod.

24. If, from any cause, it is inconvenient for the operator to place himself in front of the mirrors so as to align the sighting rod on the distant station, he may, as an alternative method, accomplish this from the rear, by looking through the hole in the centre of each mirror. When making the

alignment, by looking through the mirror from the back, it is necessary that the sighting plate (the upper portion of the sighting rod) should be turned edgewise, otherwise the distant station would be completely hidden.

After alignment, the plate must be turned round without otherwise changing the position of the rod or plate, until the sighting spot (the centre of the sighting plate) faces the exact centre of the mirror.

DAY WORK.

SUN IN REAR OF INSTRUMENT.

1. General instructions for placing the instrument in position are the same as those given when facing the sun.

2. Four mirrors are attached to the mirror bars, one at either end of each bar.

3. The sun mirrors have each a hole at their centres.

4. The station mirrors have each a disk at their centres.

5. Place the right hand sun mirror roughly facing the sun, and the right hand station mirror roughly facing the distant station.

6. Place yourself behind the station mirror, and look into the sun mirror, moving your head until you get the centre of the two mirrors in a line with your eye.

7. Then, without moving your head, adjust the direction and inclination of the station mirror until you see the reflection of the distant station coinciding with the centres of the two mirrors.

8. Clamp the *station mirror* in this position, *from which it must not be disturbed* as long as communication is kept up with the same station.

9. *Now place* yourself in rear of the sun mirror, and turn

the flash from it on to the sighting spot on disk at the centre of the station mirror, working, in all respects, as required when the instrument is facing the sun.

10. The adjustments for the left hand sun mirror and the left hand station mirror are, in all respects, the same as required for the right hand mirrors.

11. When using the four mirrors the sighting rods are removed from their upright position on the mirror bars and placed in pockets on the under side of the latter.

12. The station mirrors with disks at their centres take the place of the sighting rods, the latter being used only when the sun is in front of the instrument.

13. As an alternative method for the adjustment of four mirrors, the operator may adjust the station mirrors while standing behind the sun mirrors and looking though the holes at the centres of the latter.

The reflection of the distant station must, in this case, be made to coincide with the sighting spots at the centres of the station mirrors.

14. Attach the register for recording messages, and operate it as required by instructions under the head of "Day Work," "Instrument facing the Sun."

NIGHT WORK.

1. Place the tripod firmly on the ground, connect all the parts, and level the instrument as described for day work, except the mirrors.

2. Two lanterns, one on each mirror bar, will occupy the places taken by the two mirrors when signalling with the sun in front of the instrument. The lanterns will be attached *in precisely* the same manner as the mirrors.

3. The telescope being in position, adjust the signal carrier bar and telescope quadrant until the recorded readings for the latitude and departure of the opposite station (these readings being made during the day) are obtained, when, upon looking through the telescope, that station should appear directly within the field of vision.

4. At night the telescope can be adjusted upon a distant light, if it is known to have a fixed position in a certain direction. But it is very difficult to obtain the correct alignment without having first carefully secured during the day the latitude and departure of the point to be communicated with.

5. Having brought the opposite station within the field of the telescope, clamp the parts securely.

6. Place each lantern on the mirror bar facing the opposite station, and incline them in a direction parallel to the telescope.

The lights will then be seen from the opposite station.

7. Attach the screens as if for mirrors, one screen obscuring each lantern.

8. In transmitting signals at night, the same rule applies for making the elements of a code as for day work, viz., two lights exposed simultaneously symbolize a dash, and one light, a dot.

The element of greater magnitude always being represented by the greater signal, and *vice versa*.

9. Attach the register for recording messages, and operate it as required by instructions under the head of "Day Work." Instrument facing the sun.

10. When once in position, the lanterns will require no

further attention during the message; but before beginning a new message the lamps may require to be filled, and the wicks should be examined to see that they are in good condition. If badly charred, the wicks must be replaced by fresh ones.

11. After the telescope has been secured in the exact position required, care must be taken not to disturb it. Should its position become changed by accident, recourse must be had to the record giving the latitude and departure of the opposite station, and the instrument readjusted in the manner already described.

If weather conditions are very unfavorable it may become necessary to employ a reference light to be placed on the ground about ten feet in front of the centre of the instrument. This light is readily extemporized by kindling a small pile of fagots that can always be secured for such a purpose.

ADVANTAGES CLAIMED FOR FINLEY'S HELIOTROPE OVER SIMILAR INSTRUMENTS NOW IN USE.

1. It will transmit signals of varying magnitudes by a purely mechanical movement, relieving the mind of the operator from all effort to distinguish these signals in the same code by the longer or shorter exposition of the visible signal.

2. It will insure absolute correctness in the transmission of every signal throughout any message, and the receiver cannot fail to obtain the message correctly, letter by letter, and word by word, if the sender observes the proper precautions for adjustment of mirrors.

3. The entire instrument is mounted upon one tripod, and rigidly secured in all its parts. When necessary, the upper portion can be readily revolved upon the tripod, and faced in any direction without disturbing the firm support of the instrument.

4. The tripod is very strong, yet comparatively light, and fitted with sharp-pointed metal shoes which will permit of securing the legs very firmly in the earth even where the ground is dry and well packed.

In the present forms of heliograph the tripods are extremely light, the feet blunt, and when in use they rest lightly upon the ground, and almost invariably require to be secured in position by piling rocks about them, or weighting the entire tripod by some means or other, thus rendering the instrument very insecure and difficult to operate.

5. A telescope of great power is attached to the instrument which can be put to a variety of uses independent of its special purposes, viz., separating the signals when exposed simultaneously.

The telescope is always in position to be used without requiring any support independent of that furnished by the tripod.

6. A compass and graduated quadrant is furnished by means of which the exact location of the opposite station can be secured in a few moments during the day. The latitude and departure of the opposite station is given in degrees and minutes, and at night, should it be necessary to open communication with that station, its exact location could be found at once and brought within the field of the telescope.

7. The telescope employed is astronomical, giving greater

range of vision, simplicity of construction and operation, more serviceable and more economical, than the terrestrial glass now in use with all heliographs.

8. A register is furnished for recording the message letter by letter and word by word, no matter how long it may be necessary to make it. The record can be made as rapidly as the separate signals can be received by the eye. The register is so attached to the tripod as to be perfectly convenient to the telescope, so that while the eye of the receiver is watching the opposite station his fingers can rest upon the keys to make the record.

9. The instrument will accomplish both day and night work, and the change from one to the other is made in the simplest possible manner. This operation is fully described under the head of "Night Work."

10. One man can readily carry the entire apparatus for both day and night work, the various parts being conveniently placed in three separate cases.

The cases and contents are elsewhere described on pages 14 and 15.

11. The sighting rods are provided with a micrometer screw attachment that permits of a delicate and easy adjustment, which is entirely impossible with the usual form of frictional movement.

12. One man can completely operate the entire instrument for either day or night work, because he has under his control, in the most convenient manner, all parts of the apparatus that are necessary to the transmission and reception of messages.

In the present form of the heliograph from two to four

men are required to equip one station, because the various implements necessary to the work are entirely separated from each other, in fact, are actually distinct instruments.

13. In thick or hazy weather, when a one signal heliograph (form now in use) would show its flash very dimly, the distinction between dots and dashes, or signals of varying magnitude, is unintelligible except, perhaps, to the expert, while with the two signal instrument (Finley's heliotrope) the aid of a double signal for the dash renders the effort of the eye, in making the distinction, a comparatively easy one. If by any chance the double signal should combine into one light, its *form* and *size* would still be very distinctive as compared with the single signal. The latter is always small and round. The former is double, but if combined is large and elliptical. In transmitting dots and dashes the separation is not alone accomplished by the varying number of the signals employed, but also by the fact that they vary in magnitude; the dash signal, for example, exhibiting twice as much light as the dot signal. In any event, however, the vertical hair of the telescope will render distinctive the double signal.

14. The method of using the instrument is very easily acquired, and when once in proper adjustment, the transmission of signals, with absolute correctness, is rendered so simple that a child could operate the keys without the least fear of making an error.

15. Greater rapidity and more exactness in the transmission of signals, by the new method, must necessarily follow from the means employed in quickly and absolutely distinguishing one symbol from another, and the additional fact

that the attention of the operator to his adjustment, which are frequent and important, is not distracted by the necessity of a forced and labored manipulation of the finger key.

16. By means of the register a permanent record of every message sent or received may be made. The translation may be entered on the same sheet bearing the record of signals in each message, and the messages filed in convenient form for future reference.

17. The Finley heliotrope is peculiarly adapted for work at permanent stations, and may be operated with mirrors of any diameter. At permanent stations larger instruments are usually required than for field work, where the signalling parties frequently move from point to point. The instrument is readily serviceable for light field work, as it is entirely within the power of one man to carry the complete apparatus for both day and night work. Taking any one of the present forms of heliograph for day work, together with the clumsy torch employed for night work, and it is quite impracticable for one man to carry the apparatus without assistance.

FINALLY.

The points of superiority may be summed up as follows:

1. Signals transmitted without chance of error, by using a simple mechanical appliance.

2. Instrument operated for both day and night work, dispensing with the dirty and clumsy torch.

3. Greater rapidity of transmission of signals.

4. Greater exactness in the reception of signals.

5. A single tripod for the entire apparatus.

6. The use of a powerful astronomical telescope.

7. The use of compass and graduated quadrant to find exact location of any station.

8. Instrument set for opposite station, at once, by taking the readings of compass and quadrant obtained during the day.

9. Messages received or sent are recorded mechanically.

10. One man can completely operate the entire instrument for either day or night work.

11. The tripod can be firmly set in the ground, supporting the instrument with great stability.

12. One man can readily carry the entire apparatus for both day and night work.

13. The entire instrument, for both day and night work, is compactly distributed in three strong cases.

14. The sighting rod is delicately adjustable by a micrometer screw attachment.

15. The telescope has a firm and convenient support on the tripod, and is capable of both vertical and horizontal adjustment.

16. Only one man required to assume charge of a single station.

17. Messages may be transmitted in thick or hazy weather because of the great strength of the light in the double signal and its ready distinction from the single signal.

18. A man with the code before him, and otherwise entirely uninstructed, can transmit signals without the least fear of error.

19. The screens are adjusted with the utmost simplicity and can readily be arranged for the forming of signals by *either the obscuration* or flash systems.

20. The signal carrier bar is graduated both ways from the centre of the instrument, so that the mirrors or lanterns can be adjusted for ranges of varying lengths.

21. The entire instrument is revolvable upon the tripod and can be firmly clamped in any position.

22. One setting of the tripod will permit of opening communication with any point on the entire circle of the horizon.

23. The lanterns replace the mirrors for night work and the change is made in an instant.

24. The lanterns are compact, strong, and easily adjusted in any direction in a horizontal plane while attached to the instrument.

25. The lamp-wicks and reflectors are specially prepared to give a strong, steady, and brilliant light.

26. Night signals are made by using the same screens as are employed for day work.

27. The astronomical telescope employed, while it inverts the image, gives greater distinctness of vision, a longer range, and readier manipulation. In every way it is superior to the terrestrial telescope now used with every form of heliograph.

28. In the vast amount of signalling with the heliotrope, regularly carried on by the United States Coast and Geodetic Survey, the astronomical telescope is invariably used.

29. The operator soon becomes accustomed to the inverted image in the case of buildings, trees, or persons, but in looking at a sun flash, or light, the effect of inversion of course is not apparent, and therefore offers not the least difficulty to those unaccustomed to the use of the astronomical glass.

30. The telescope is provided with a vertical hair (finely drawn platinum wire) properly adjusted near the eye-piece, which affords the means of producing a mechanical separation of the two lights or flashes in the double signal.

CODES.

The following codes which are best known, for purposes of signalling to the Armies and Navies of this country and England, are published for the information of those interested in the progress of this art, and to show how readily the elements can be symbolized by the new heliotrope:

ARMY AND NAVY CODE.

(ENGLISH).

The standard code by orders of the War Department.

A · —	G — — ·	M — —	S · · ·
B — · · ·	H · · · ·	N — ·	T —
C — · — ·	I · ·	O — — —	U · · —
D — · ·	J · — — —	P · — — ·	V · · · —
E ·	K — · —	Q — — · —	W · — —
F · · — ·	L · — · ·	R · — ·	X — · · —
	Y — · — —	Z — — · ·	

NUMERALS.

1	2	3	4
· — — — —	· · — — —	· · · — —	· · · · —
5	**6**	**7**	**8**
· · · · ·	— · · · ·	— — · · ·	— — — · ·
9	**0**		
— — — — ·	— — — — —		

PUNCTUATION.

Period (.) .. .. ..

The dash (—) is formed by the simultaneous exposition of two signals (lights, flashes, or obscurations).

The dot (.) is formed by the exposition of one signal (light, flash, or obscuration).

This code has supplanted all others for military purposes, because of its simplicity and universality.

GENERAL SERVICE CODE.

(Used throughout the Army of the United States during the war of the rebellion, and the standard code up to March, 1886, when, by the orders of the War Department, it was replaced by the "Army and Navy Code" previously described.

A	11	G	1122	M	2112	S	121
B	1221	H	211	N	22	T	1
C	212	I	2	O	12	U	221
D	112	J	2211	P	2121	V	2111
E	1112	K	1212	Q	2122	W	2212
F	1122	L	112	R	122	X	1211
Y	222	Z	1111	&	2222	tion	2221
ing	1121						

NUMERALS.

1.	2.	3.	4.
12221	21112	11211	11121
5.	6.	7.	8.
11112	21111	22111	22221
	9.	0.	
	22122	11111	

The figure 2 is formed by the simultaneous exposition of two signals (lights, flashes, or obscurations).

The figure 1 is formed by the exposition of one signal (light, flash, or obscuration).

CONCLUSION.

A cursory examination of these codes, in connection with the operation of the new heliotrope, reveals the fact, at once apparent, that the transmission of signals by sun flashes by day, and artificial light by night, becomes a question of extreme simplicity, absolute accuracy, and increased rapidity, coupled with many incidental advantages of more or less importance.

The attention of the officers of the Regular Army and Navy, and of the Militia of the United States, is called to the importance of this new invention in the art of signalling.

For further information concerning the Finley Heliotrope communications should be addressed to the Secretary of the American Helio-Telegraph and Signal Light Company.